

Pictorial keys to the genera of mosquitoes, subgenera of *Culex* and the species of *Culex* (*Culex*) occurring in southwestern Asia and Egypt, with a note on the subgeneric placement of *Culex deserticola* (Diptera: Culicidae)¹

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ABSTRACT. Pictorial keys to the adults and larvae of the known genera of mosquitoes, subgenera of *Culex* and the species of *Culex* (*Culex*) of southwestern Asia and Egypt are provided for the use of field workers. Reasons are given for placing *Culex deserticola* Kirkpatrick in the subgenus *Maillotia*.

INTRODUCTION

The known mosquito fauna of southwestern Asia, including Egypt, consists of 111 species belonging to seven genera and 21 subgenera. At least 25 of these species reportedly are involved in the transmission of pathogens that cause human disease. Unfortunately, our ability to identify possible vector species in this region is limited because available keys are obsolete, unreliable or useful only in limited geographical areas. Nowhere in the region has the mosquito fauna been studied thoroughly in light of modern taxonomic techniques and concepts.

In 1982, a revisionary study of the subgenus *Culex* was undertaken to help fill the need for up-to-date, reliable guides and keys to the mosquito fauna of southwestern Asia. The pictorial keys presented below are based on this revision. The keys are being published in advance of the revision to assist field workers in recognizing vector species.

Southwestern Asia is defined as the tract of land south of the USSR between the Mediterranean Sea and India, including Turkey and the Arabian Peninsula (Map 1). The eastern part of Pakistan lying along the arid plain of the Indus River is excluded from consideration here because its mosquito fauna is almost entirely Oriental. Egypt is included in its entirety although only the Sinai Peninsula is actually a part of Asia. All of the species of *Culex* (*Culex*) found in Egypt west of the

1. The views of the author do not purport to reflect the position of the Department of the Army or the Department of Defense.

Gulf of Suez also occur in parts of southwestern Asia.

Thirty-four species of *Culex* from seven subgenera are known to occur in the region just defined (Table 1). Twenty of these belong to the subgenus *Culex*. At least 10 species of *Culex* (*Culex*) are involved or implicated in the transmission of pathogens that cause filariasis and arboviral disease, e.g., *Wuchereria bancrofti*, Rift Vally Fever, West Nile, Sindbis and Japanese encephalitis viruses.

SYSTEMATICS

Individuals using the subgeneric key will find that *Culex deserticola* Kirkpatrick keys to the subgenus *Maillotia* instead of *Neoculex*. During studies on these subgenera, it became apparent that *deserticola* has features in common with the species of *Maillotia* occurring in southwestern Asia. In the adult, these features include the presence of postspiracular and prealar scales and similarities in the shape of the male phallosome. In the larva, seta 3-P is nearly as long as 1,2-P, 2-S is hooked and the siphon bears a dorsolateral row of setae. Based on these similarities, *deserticola* hereby is placed in *Maillotia*.

Information on the systematics of the species of *Culex* (*Culex*) listed in Table 1 is reserved for inclusion in the aforementioned revision. Users will notice that *Culex thalassius* Theobald and *Cx. ethiopicus* Edwards are not included in the table although they were recorded previously from localities in southwestern Asia. These species are not regarded as elements in the mosquito fauna of the region for reasons which will be discussed in detail in the revision. Specimens from the southern part of the Arabian Peninsula previously identifiable as *ethiopicus* will key to *Cx. bitaeniorhynchus* Giles in the keys below.

The distributions of the species of *Culex* (*Culex*) are summarized in Table 2. These are based on the material examined for the revision, as well as on the literature records. The table includes a few questionable literature records which will be pointed out and discussed in the revision. Some new occurrence records are indicated to aid workers in making identifications.

ACKNOWLEDGMENTS

The author is grateful to Bruce A. Harrison, E.L. Peyton and Ronald A. Ward for commenting on the manuscript. Special recognition is due Taina Litwak who skillfully and patiently prepared the pictorial keys and Thomas Gaffigan for typing the final manuscript. Sherif el Said, Ain Shams University, Cairo, Egypt, and Joel Margalit, Ben Gurion University of the Negev, Beer Sheva, Israel, are acknowledged for their assistance in acquiring some of the material that was examined and used in the preparation of the keys.

TABLE 1. Species of *Culex* known from southwestern Asia and Egypt.

1. *Culex* (*Barraudius*) *modestus* Ficalbi*
2. *Culex* (*Barraudius*) *pusillus* Macquart
3. *Culex* (*Culex*) *antennatus* (Becker)*
4. *Culex* (*Culex*) *bitaeniorhynchus* Giles*
5. *Culex* (*Culex*) *decens* Theobald
6. *Culex* (*Culex*) *duttoni* Theobald
7. *Culex* (*Culex*) *laticinctus* Edwards
8. *Culex* (*Culex*) *mattinglyi* Knight
9. *Culex* (*Culex*) *mimeticus* Noé
10. *Culex* (*Culex*) *perexiguus* Theobald*
11. *Culex* (*Culex*) *pipiens* Linnaeus*
12. *Culex* (*Culex*) *poicilipes* (Theobald)
13. *Culex* (*Culex*) *pseudovishnui* Colless*
14. *Culex* (*Culex*) *quinquefasciatus* Say*
15. *Culex* (*Culex*) *simpsoni* Theobald
16. *Culex* (*Culex*) *sinaiticus* Kirkpatrick
17. *Culex* (*Culex*) *sitiens* Wiedemann*
18. *Culex* (*Culex*) *theileri* Theobald*
19. *Culex* (*Culex*) *torrentium* Martini
20. *Culex* (*Culex*) *tritaeniorhynchus* Giles*
21. *Culex* (*Culex*) *univittatus* Theobald*
22. *Culex* (*Culex*) *vagans* Wiedemann
23. *Culex* (*Culiciomyia*) *nebulosus* Theobald
24. *Culex* (*Lasiosiphon*) *adairi* Kirkpatrick
25. *Culex* (*Lutzia*) *tigripes* de Grandpre and de Charmoy
26. *Culex* (*Maillotia*) *arbieeni* Salem
27. *Culex* (*Maillotia*) *deserticola* Kirkpatrick
28. *Culex* (*Maillotia*) *hortensis* Ficalbi
29. *Culex* (*Maillotia*) *quettensis* Mattingly
30. *Culex* (*Maillotia*) *salisburyensis* Theobald
31. *Culex* (*Neoculex*) *impudicus* Ficalbi
32. *Culex* (*Neoculex*) *judaicus* Edwards
33. *Culex* (*Neoculex*) *martinii* Medschid
34. *Culex* (*Neoculex*) *territans* Walker

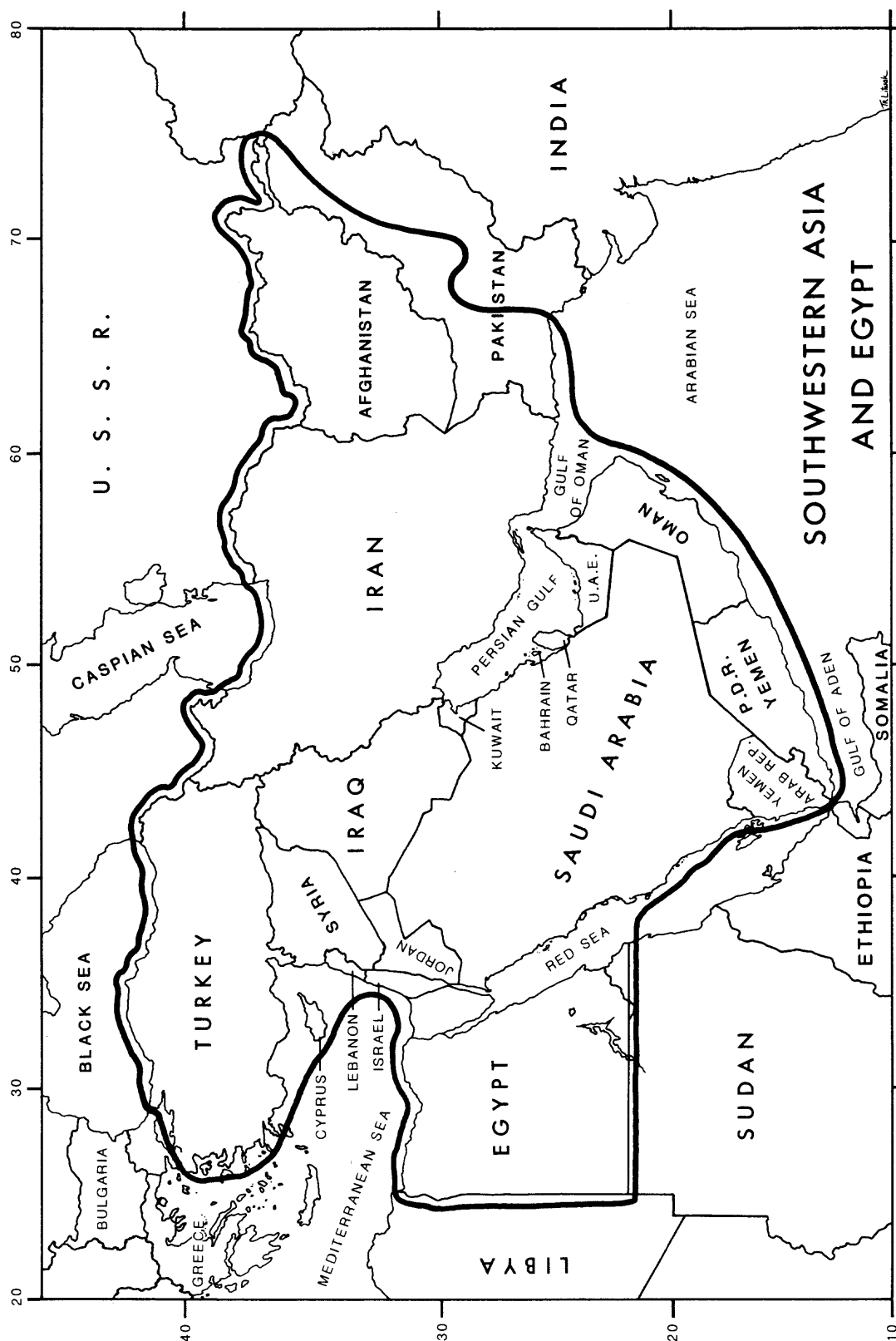
* Species involved or implicated in the transmission of pathogens that cause filarial and arboviral disease in humans.

TABLE 2. Distributions of *Culex* (*Culex*) in southwestern Asia and Egypt.

	Afghanistan	Bahrain	Egypt	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Pakistan	Qatar	Saudi Arabia	Syria	Turkey	United Arab Emirates	Yemen Arab Republic	P.D.R. Yemen
<i>antennatus</i>			X	X		X												
<i>bitaeniorhynchus</i>				X							X						X	X
<i>decens</i>																	X	X
<i>duttoni</i>																		X
<i>laticinctus</i>			X	X	X	X	X		X	X			X	X	X		X	X
<i>mattinglyi</i>													X				X	
<i>mimeticus</i>	X		X	X	X	X	X		X		X		X	X	X			
<i>perexiguus</i>	X		X	X	X	X	X		X	X	X		X	X	X			
<i>pipiens</i>	X		X	X	X	X	X		X		X		X	X	X		X	X
<i>poicilipes</i>			X			*												
<i>pseudovishnui</i>	X			X							X							
<i>quinquefasciatus</i>		X		X	X			X		X	X	X	X			X	X	X
<i>simpsoni</i>																	X	*
<i>sinaiticus</i>			X	X		X	X			X			X				X	X
<i>sitiens</i>				X						X			*			X	X	X
<i>theileri</i>	X		X	X	X	X	X		X		X		X	X	X		X	X
<i>torrentium</i>				X	X										X			
<i>tritaeniorhynchus</i>			X	X	X	X	X		X	X	X		X	X	X		X	X
<i>univittatus</i>																	X	*
<i>vagans</i>	*		X								X							

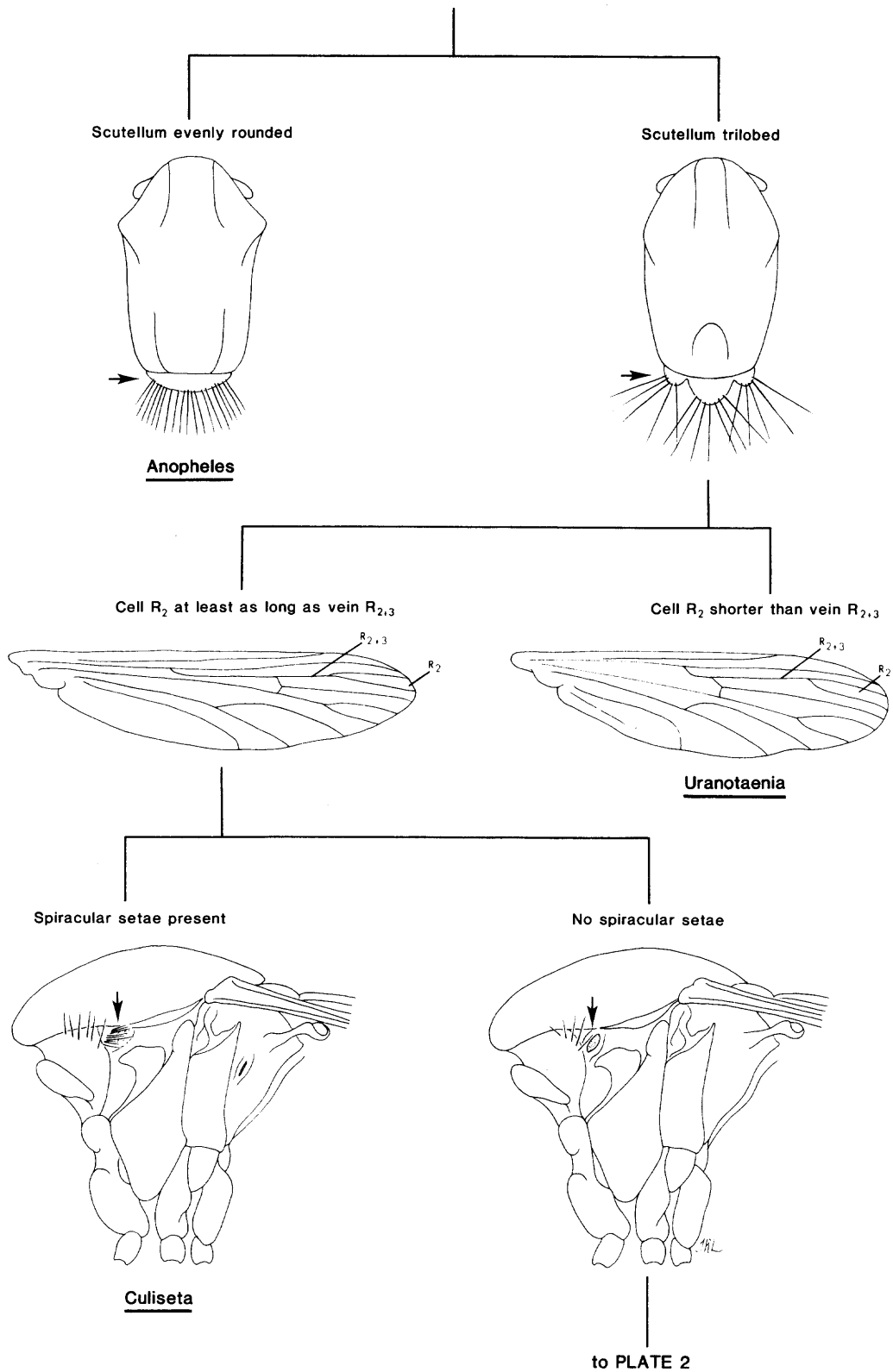
* Indicates a new occurrence record.

MAP 1



Adult Key to Genera

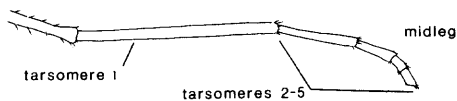
PLATE 1



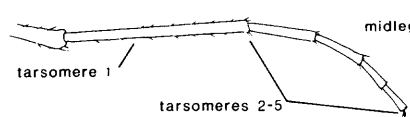
From PLATE 1: no spiracular setae

PLATE 2

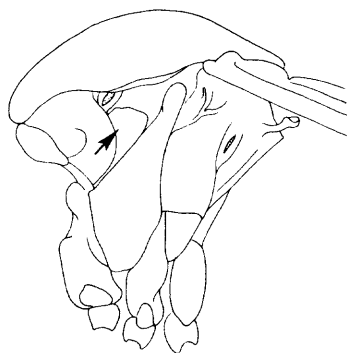
Tarsomere 1 of fore- and midlegs distinctly longer than tarsomeres 2-5 combined

Orthopodomyia

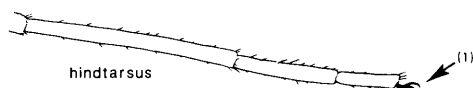
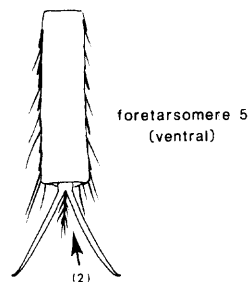
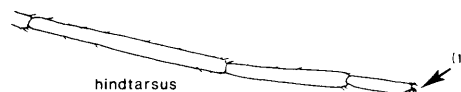
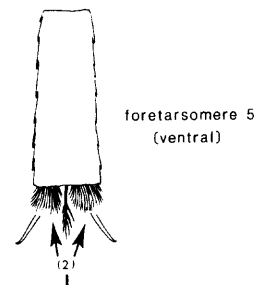
Tarsomere 1 of fore- and midlegs no longer than tarsomeres 2-5 combined



No postspiracular setae



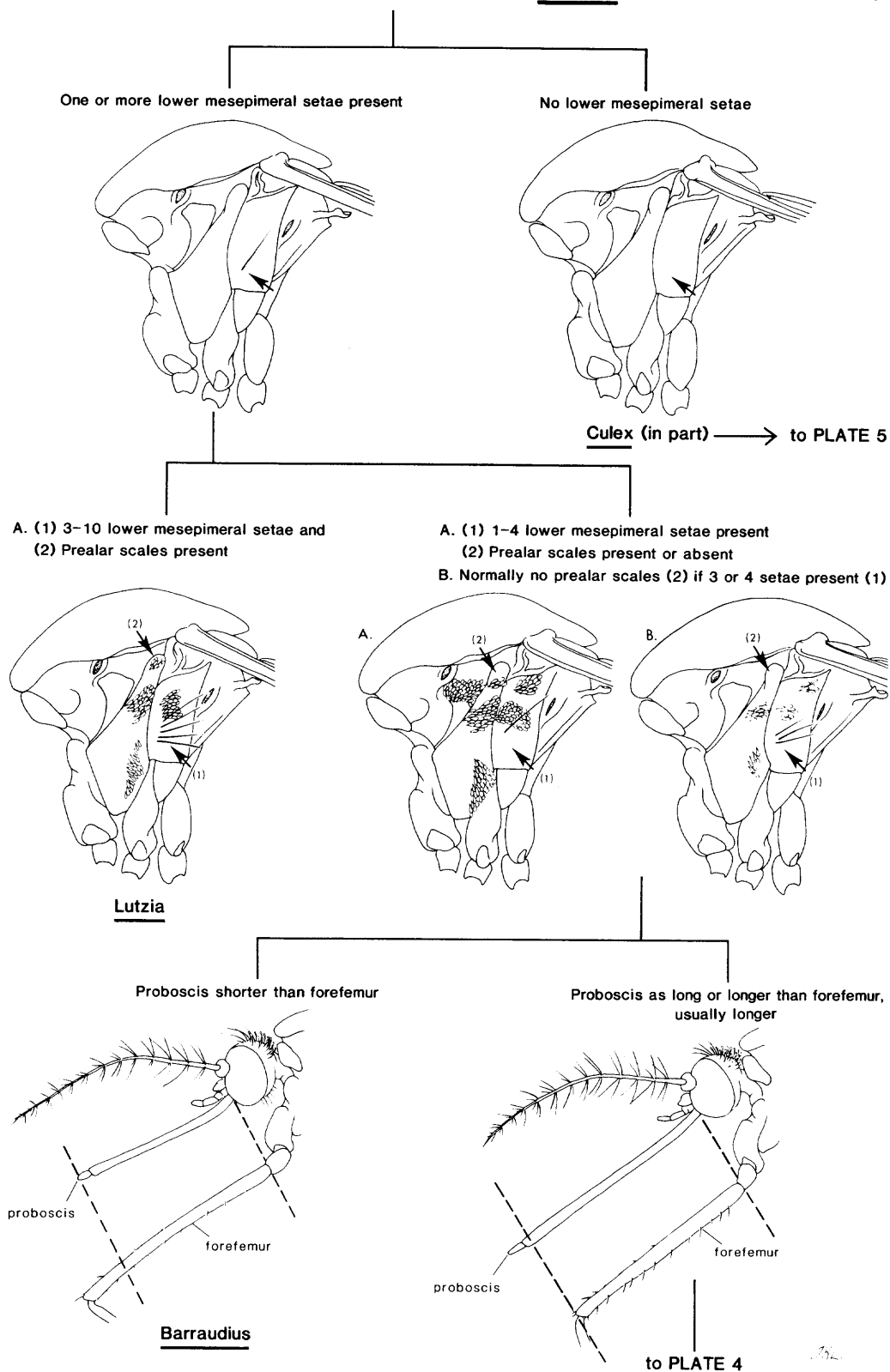
Postspiracular setae present

Aedes(1) Hindungues large and conspicuous
(2) Pulvilli absent(1) Hindungues small and inconspicuous
(2) Pulvilli presentCoquillettidiaCulex (to PLATE 3)

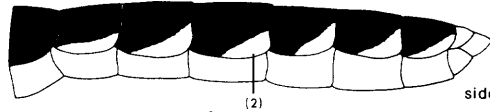
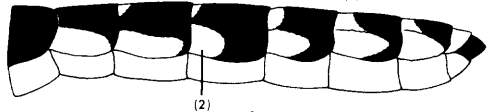
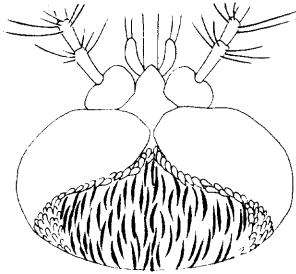
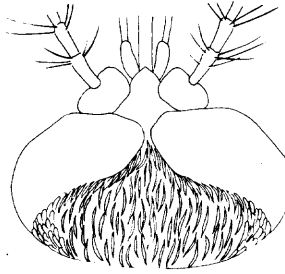
JAL

Adult Key to Subgenera of Culex

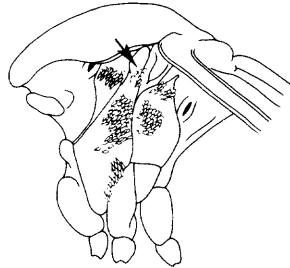
PLATE 3



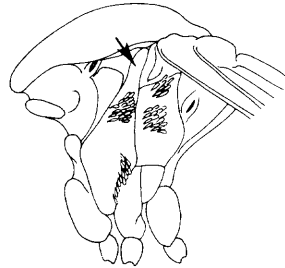
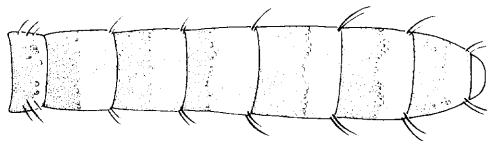
From PLATE 3: proboscis longer than forefemur

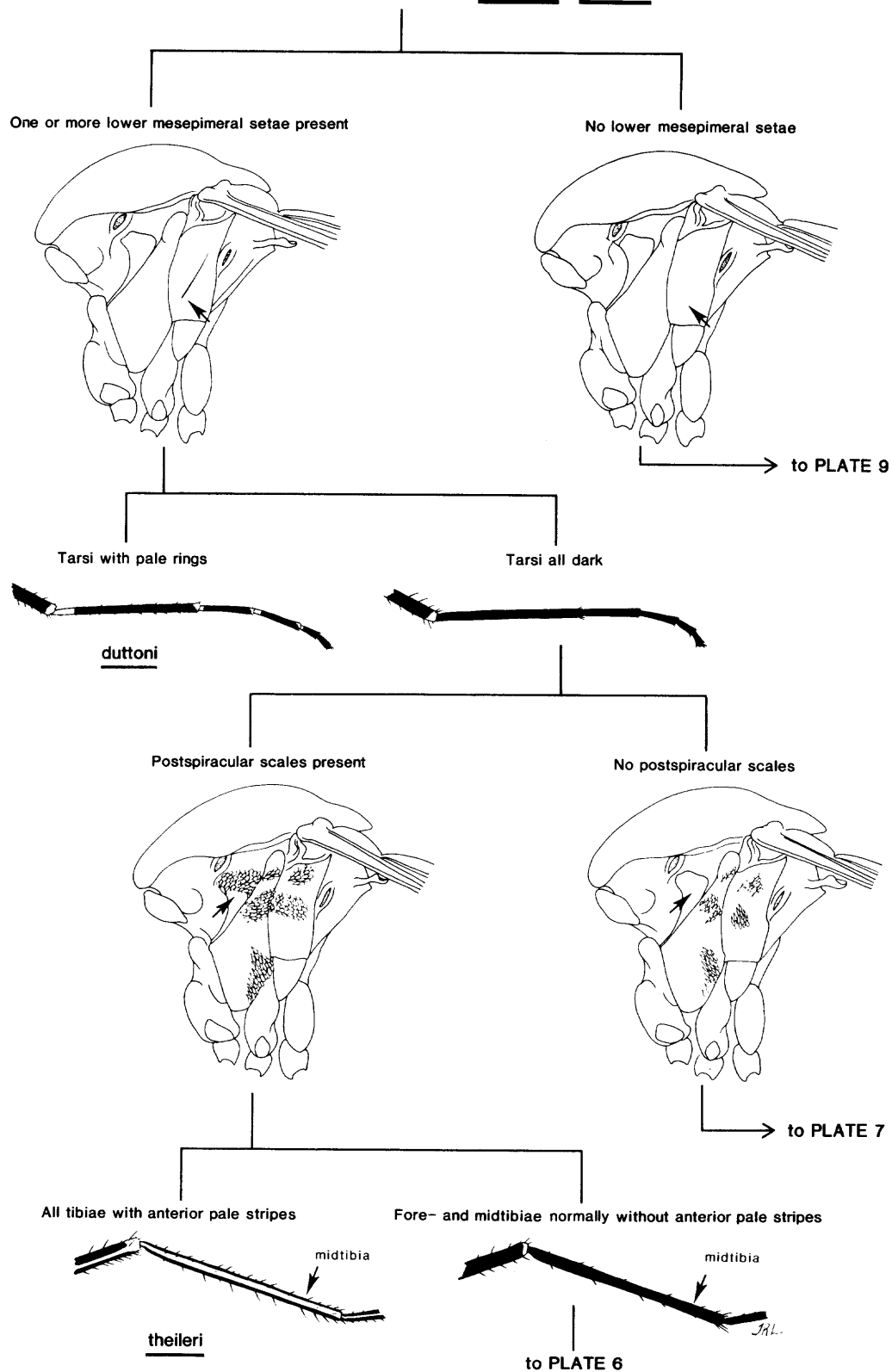
PLATE 4Abdominal terga with apical pale markings
(bands (1) and/or lateral spots (2)) or entirely darkAbdominal terga with basal pale markings
(bands (1) and/or lateral spots (2))→ Culex (in part)
to PLATE 5Decumbent scales of vertex mainly narrow and dark,
those along margin of eye broad and whiteCuliciomyiaAll decumbent scales of vertex
narrow and pale

Prealar scales present

Maillotia

No prealar scales

Small pale species, apical markings
of abdominal terga yellowish and indistinct
against pale brown backgroundLasiosiphonLarger, darker species, apical markings
of terga white and well contrasted against
black or nearly black backgroundNeoculex



From PLATE 5: fore- and midtibiae without anterior pale stripes

PLATE 6

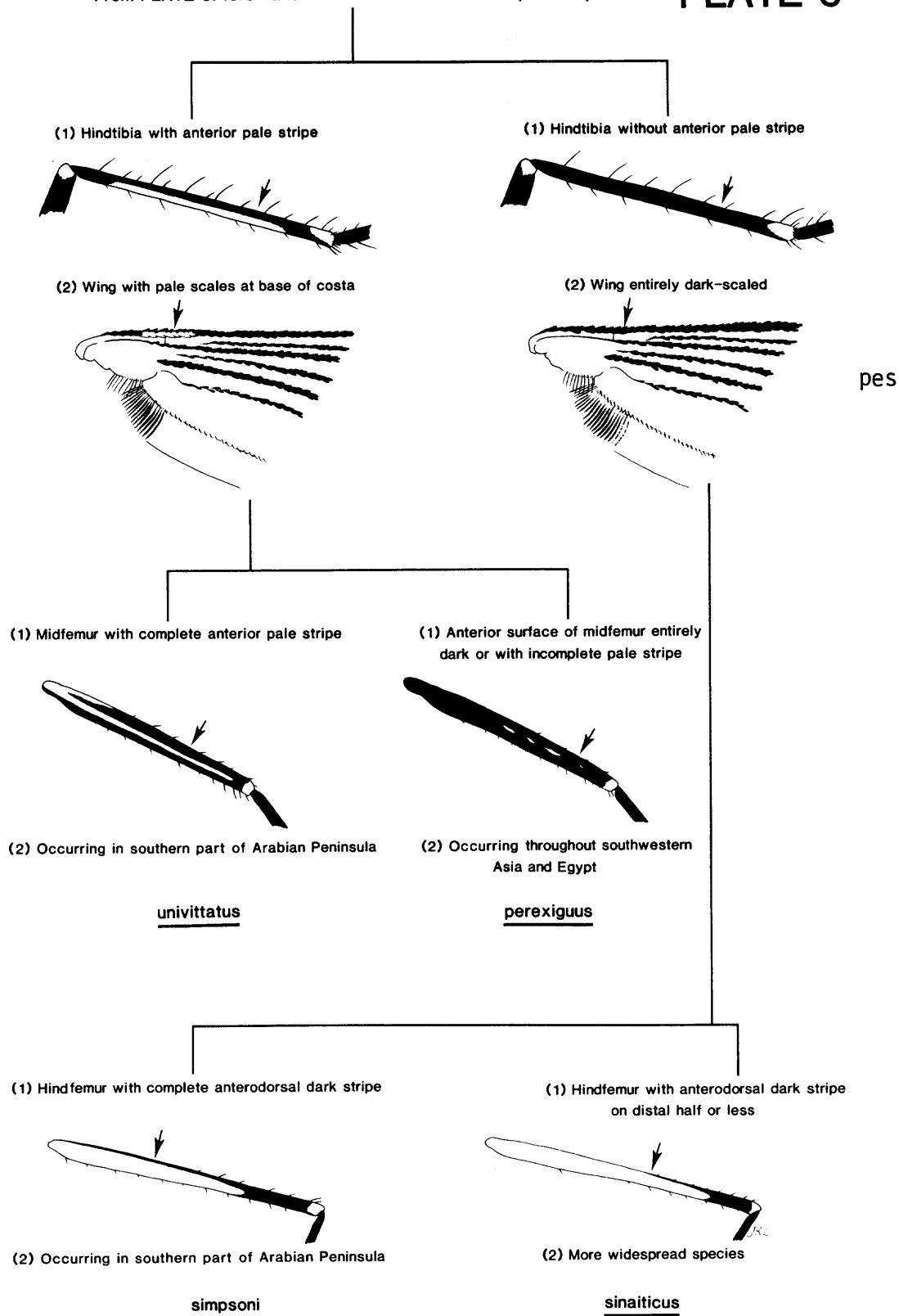
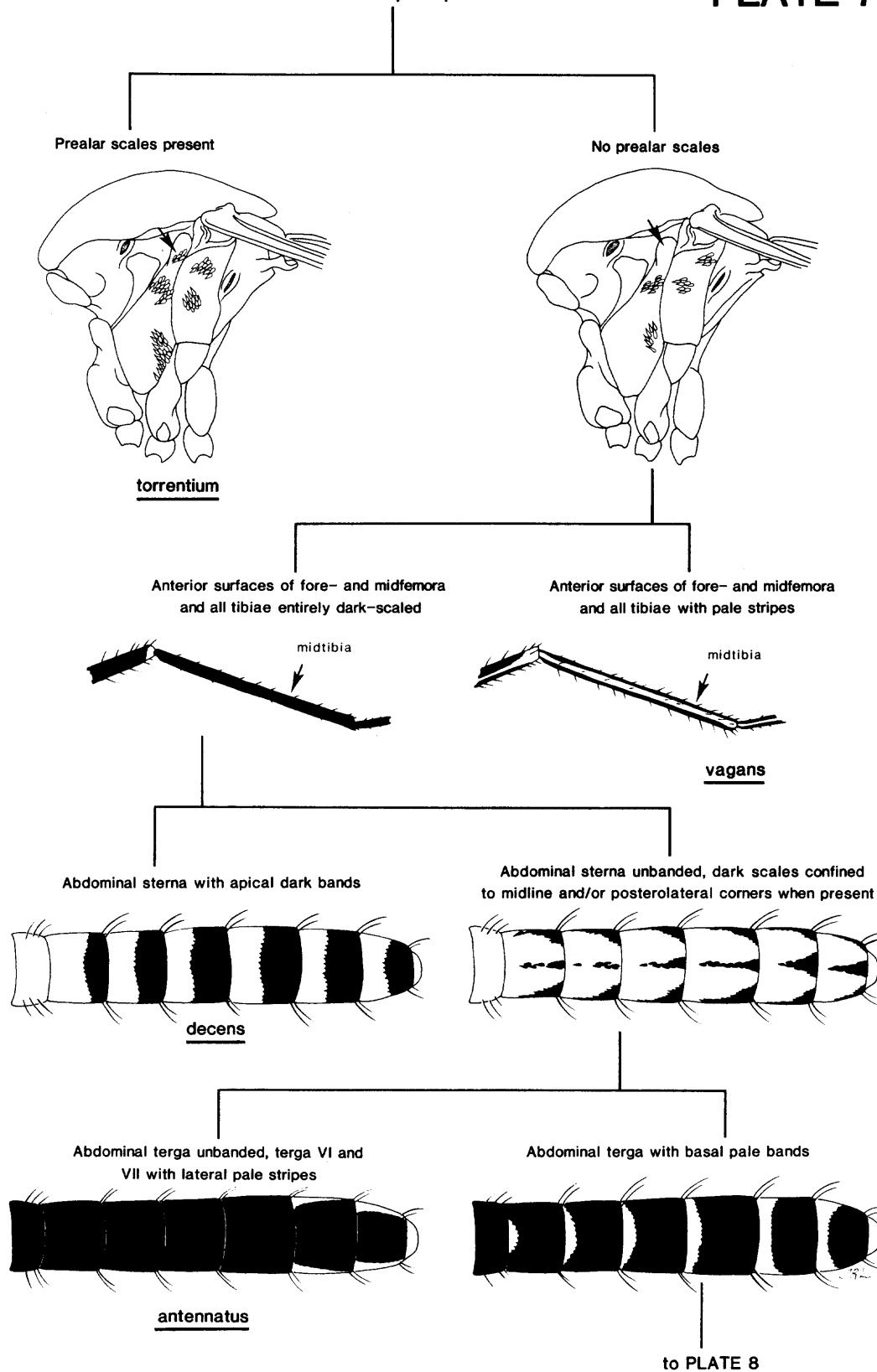


PLATE 7

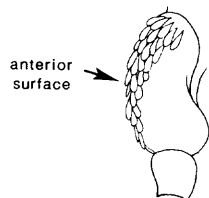
From PLATE 5: no postspiracular scales



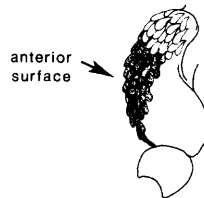
From PLATE 7: abdominal terga with basal pale bands

PLATE 8

(1) Scales of forecoxa all pale



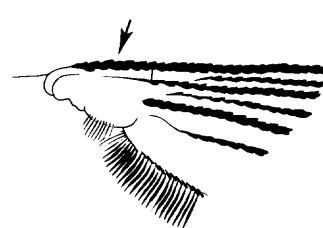
(1) Forecoxa with some dark scales, usually mostly dark



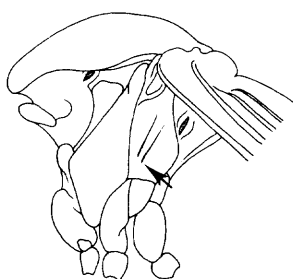
(2) Wing with pale scales at base of costa



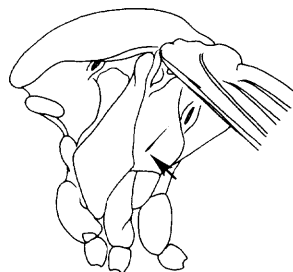
(2) Wing entirely dark-scaled



(1) Two or three (but often only one) lower mesepimeral setae present



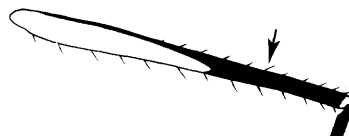
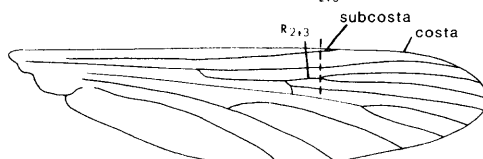
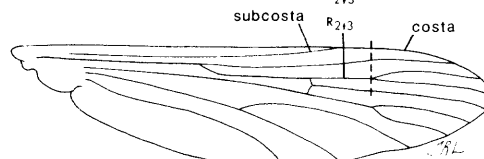
(1) Only one lower mesepimeral seta present



(2) Hindfemur with distal 0.2-0.3 of anterior surface dark-scaled

laticinctus

(2) Hindfemur with distal 0.3-0.4 of anterior surface dark-scaled

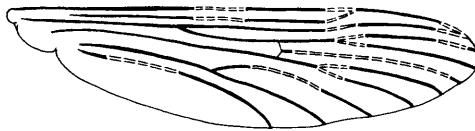
mattinglyiSubcosta intersects costa at or beyond level of furcation of R_{2+3} ★pipiensSubcosta intersects costa before level of furcation of R_{2+3} ★quinquefasciatus

★This character is unreliable in central and northeastern areas of the Arabian Peninsula where introgressed populations (hybrids) occur.

PLATE 9

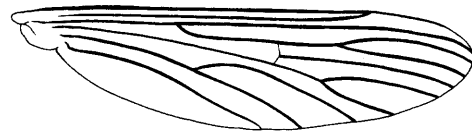
From PLATE 5: no lower mesepimeral setae

Wing with pattern of pale spots

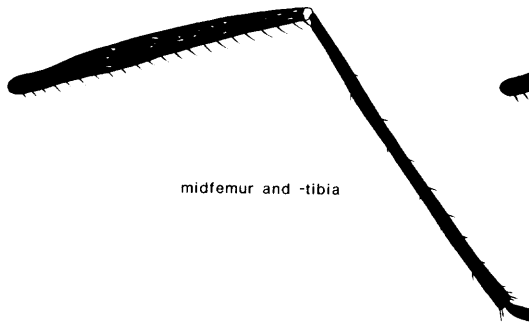


mimeticus

Wing either speckled, entirely dark-scaled or with variable amount of pale scaling along anterior veins

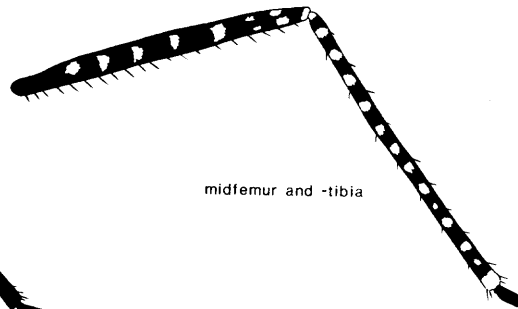


Anterior surfaces of femora and tibiae speckled or entirely dark-scaled



midfemur and -tibia

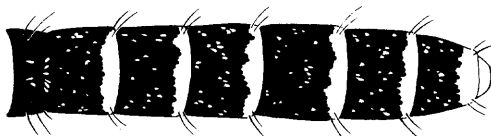
Anterior surfaces of femora and tibiae with rows of small pale spots



midfemur and -tibia

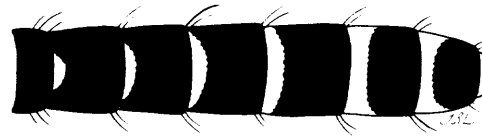
poecilipes

Abdominal terga with apical pale bands



bitaeniorhynchus

Abdominal terga with basal pale bands

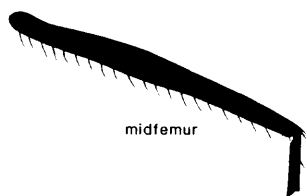


to PLATE 10

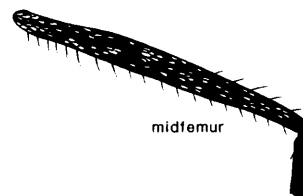
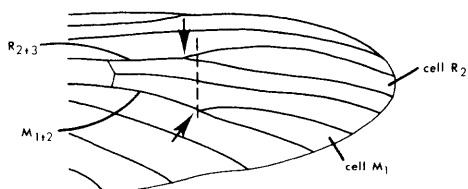
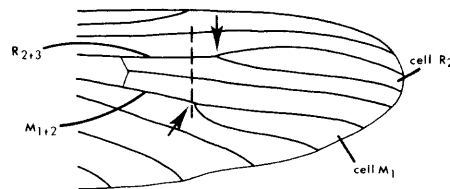
PLATE 10

From PLATE 9: abdominal terga with basal pale bands

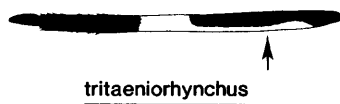
(1) Anterior surfaces of fore- and midfemora entirely dark-scaled



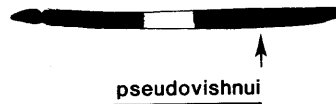
(1) Anterior surfaces of fore- and midfemora with scattered pale scales

(2) Furcation of vein R_{2+3} proximal to furcation of vein M_{1+2} (2) Furcation of vein R_{2+3} distal to furcation of vein M_{1+2} sitiens

Pale ring of proboscis extended proximally on ventral surface *



Pale ring of proboscis without proximal extension on ventral surface



* In many specimens, the ventral extension is weak or absent in the middle and the proboscis bears an isolated spot proximal to the ring.

Larval Key to Genera

PLATE 11

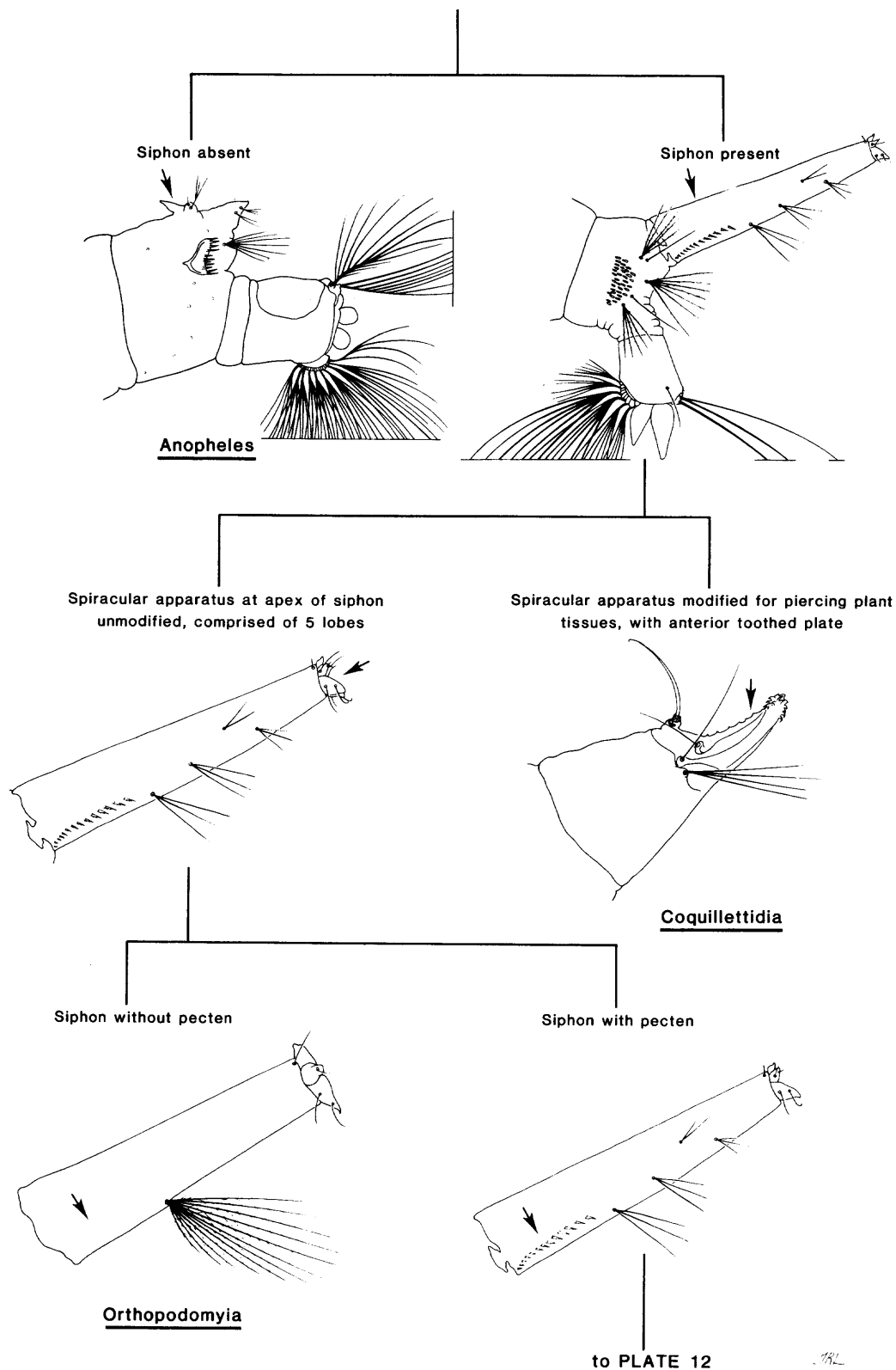
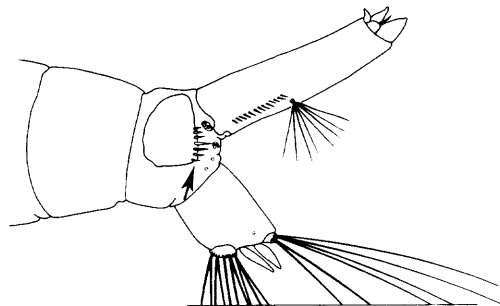


PLATE 12

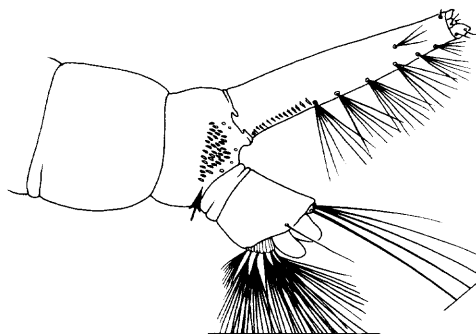
From PLATE 11: siphon with pecten

Comb scales arising from a sclerotized plate

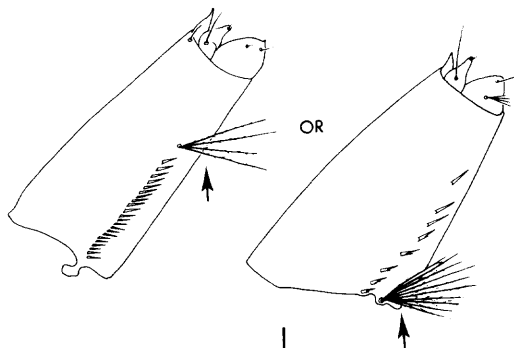


Uranotaenia

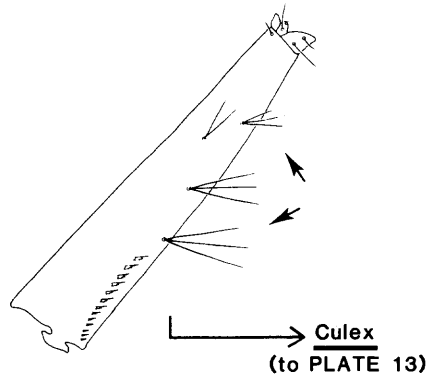
Comb scales arising from unsclerotized integument



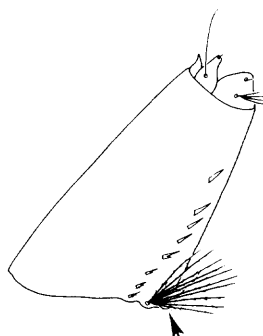
Siphon with one pair of seta 1-S



Siphon with at least 3 pairs of seta 1-S, usually more

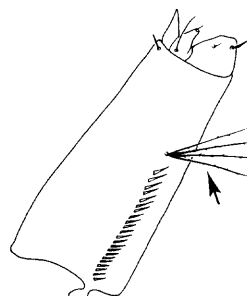


Seta 1-S arising near base of siphon



Culiseta

Seta 1-S arising in middle part of siphon



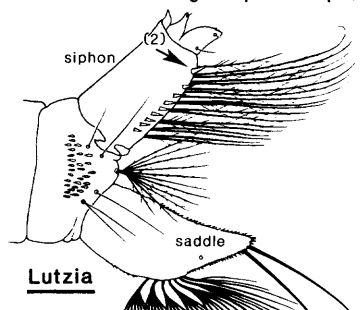
Aedes

JAL

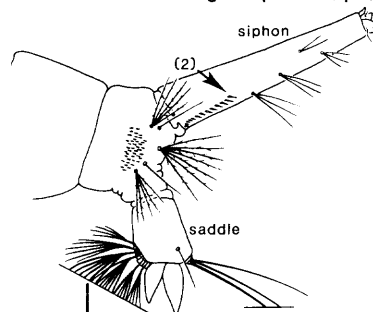
Larval Key to Subgenera of Culex

PLATE 13

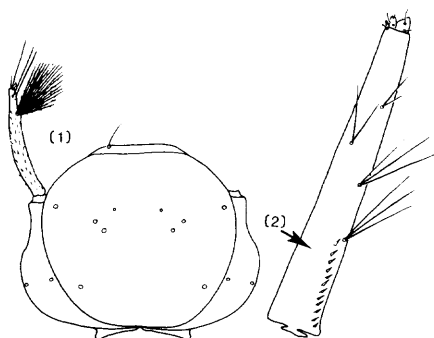
- (1) Saddle longer than siphon
(2) Pecten extending to apex of siphon



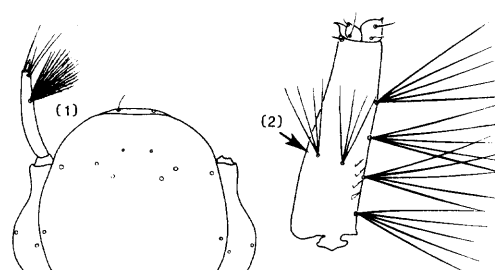
- (1) Saddle shorter than siphon
(2) Pecten not extending to apex of siphon



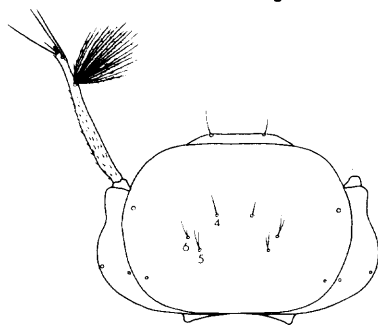
- (1) Antenna longer than half length of head
(2) Siphon without lateral pair of transversely-aligned setae adjacent to pecten



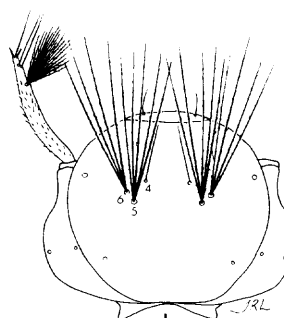
- (1) Antenna shorter than half length of head
(2) Siphon with lateral pair of transversely-aligned setae adjacent to pecten

Culiciomyia

- Setae 5- and 6-C short and inconspicuous,
about same thickness and length as 4-C



- Setae 5- and 6-C long and conspicuous,
much thicker and longer than 4-C

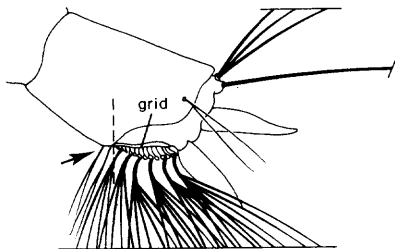


to PLATE 14

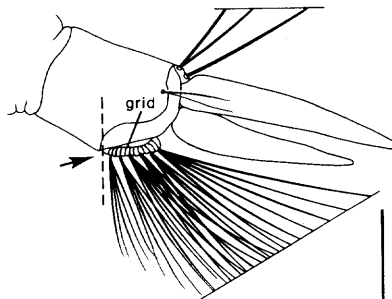
From PLATE 13: setae 5- and 6-C long and conspicuous

PLATE 14

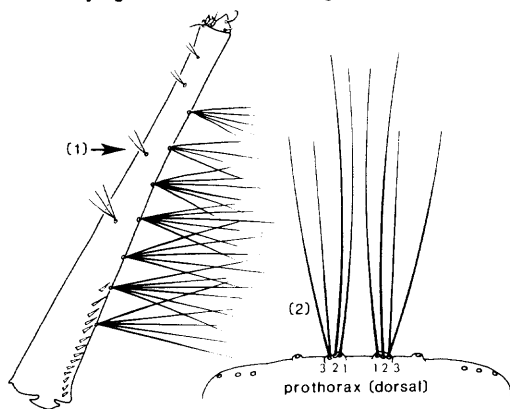
Ventral brush with 1 or more setae borne anterior to grid



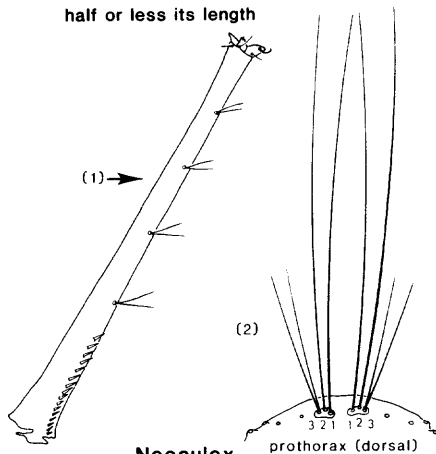
Ventral brush with all setae borne on grid



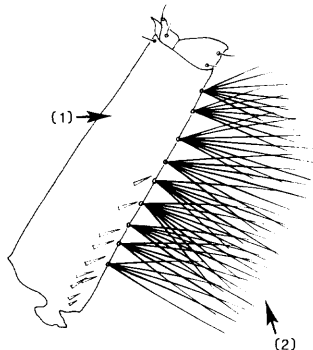
- (1) Siphon with 2 or more anterolateral setae on each side
 (2) Seta 3-P of thorax nearly as long as 1-P, always greater than half its length

Maillotia

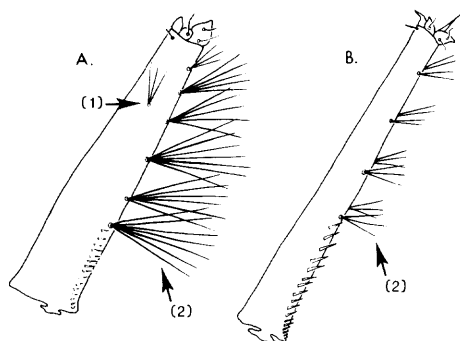
- (1) Siphon without anterolateral setae
 (2) Seta 3-P much shorter than 1-P, half or less its length

Neoculex

- A. (1) Siphon without lateral setae,
 (2) All setae in single posterior row

Barraudius

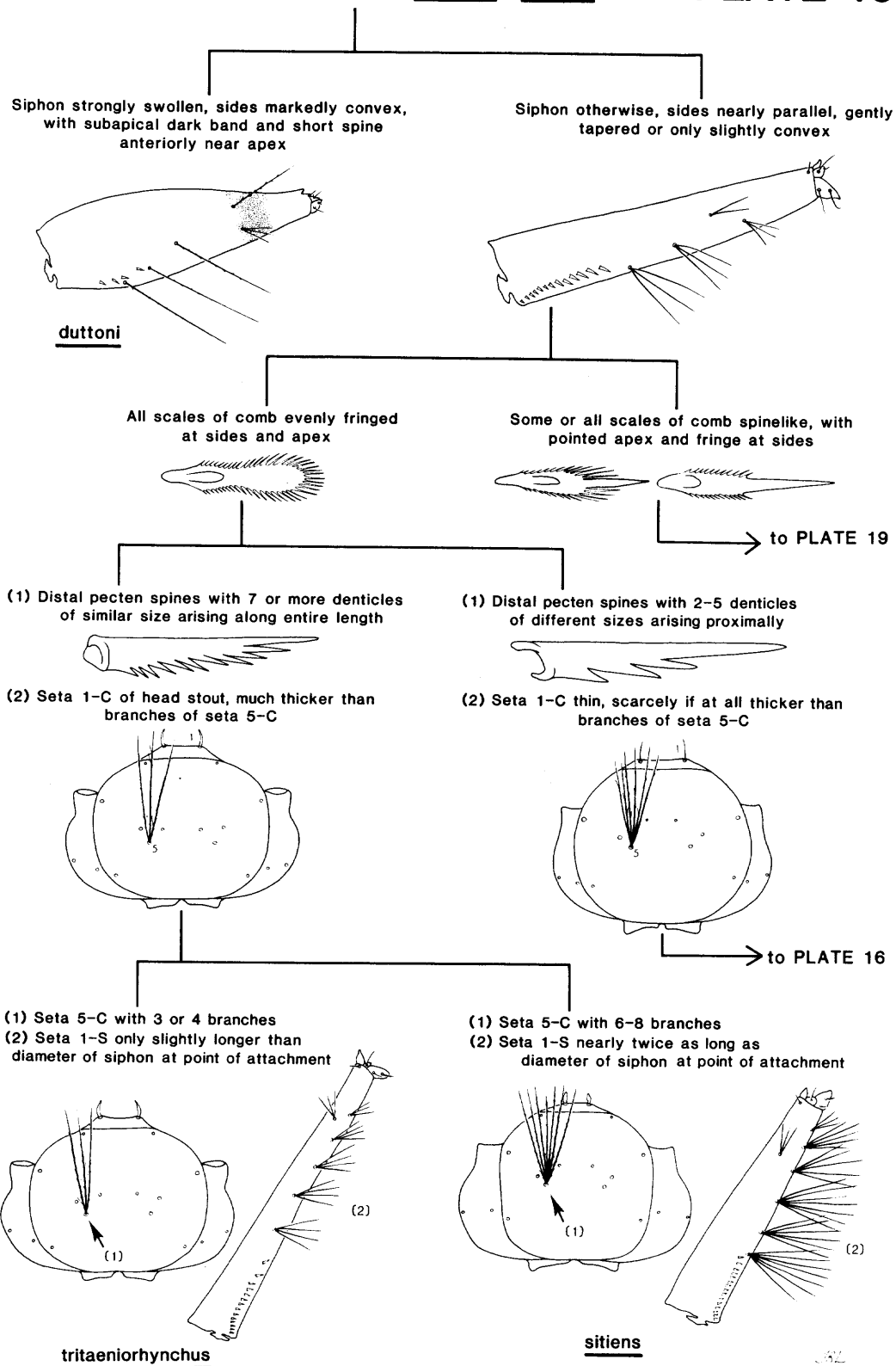
- A. (1) Siphon with 1-3 lateral setae,
 (2) Other setae in single or double row
 B. If no lateral seta, then all setae are in 2 posterolateral rows

Culex (to PLATE 15)

JAL

Larval Key to Species of Culex (Culex)

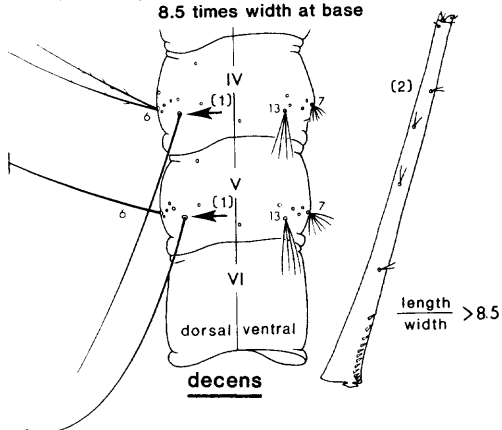
PLATE 15



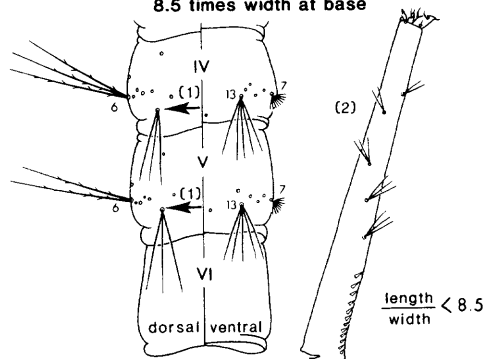
From PLATE 15: pecten spines with 2-5 denticles; seta 1-C thin

PLATE 16

- (1) Seta 1-IV,V of abdomen single and much longer than length of 2 abdominal segments
 (2) Siphon very long and slender, length more than 8.5 times width at base

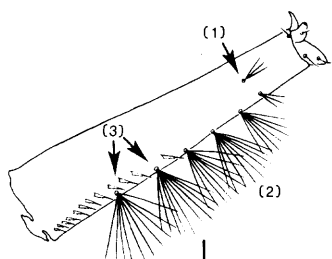


- (1) Seta 1-IV,V shorter than length of 2 abdominal segments, with 1 or more branches
 (2) Siphon not as long and slender, length less than 8.5 times width at base



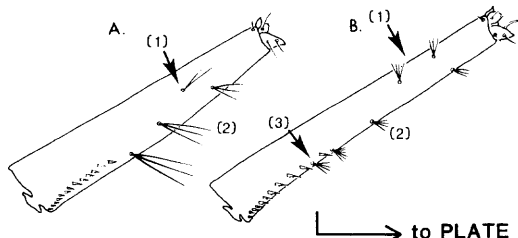
Siphon with 6-8 pairs of seta 1-S,

- A. (1) with 1 lateral pair,
 (2) with 5-7 pairs arising along posterior midline and
 (3) with 2 pairs arising before end of pecten

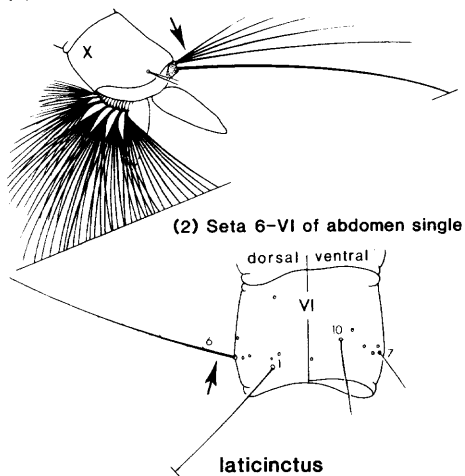


Siphon with 3-6 pairs of seta 1-S,

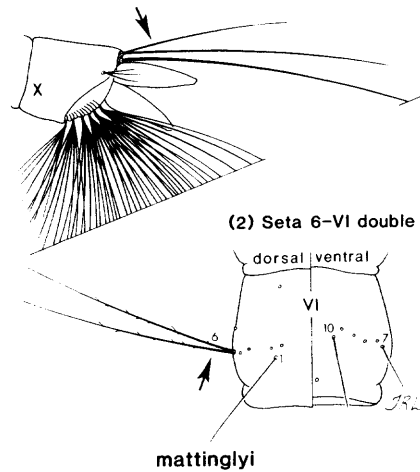
- A. (1) with 1-3 lateral pairs,
 (2) with 2-4 posterolateral pairs and
 B. (3) sometimes with 1 pair arising before end of pecten



- (1) Seta 2-X of abdomen with 4 or 5 branches



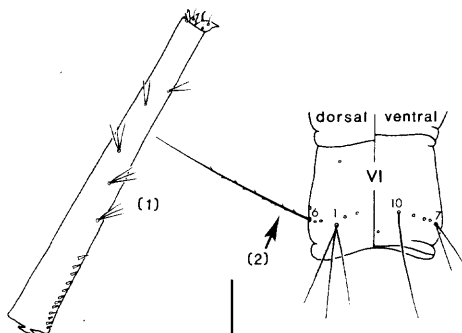
- (1) Seta 2-X with 2 or 3 branches



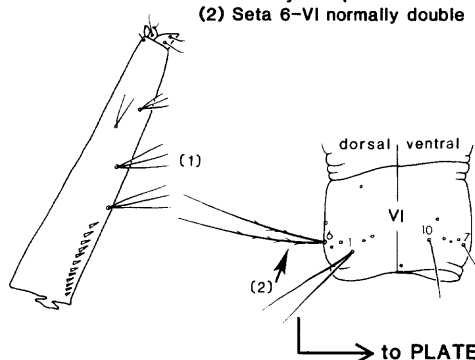
From PLATE 16: seta 1-S in 3-6 pairs

PLATE 17

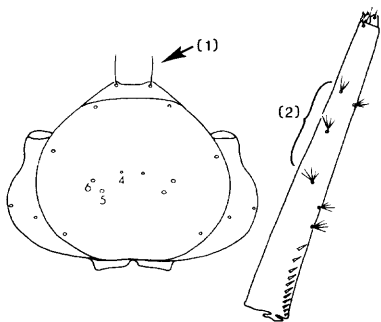
- (1) Seta 1-S no longer than diameter of siphon at point of attachment, usually in 5 pairs
 (2) Seta 6-VI of abdomen normally single



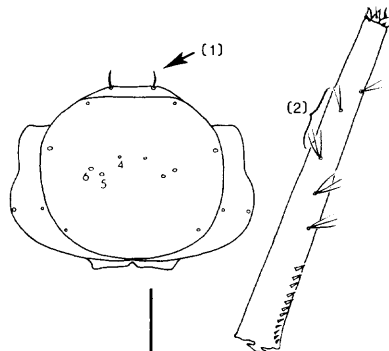
- (1) Seta 1-S (at least some elements) longer than diameter of siphon at point of attachment, usually in 4 pairs
 (2) Seta 6-VI normally double



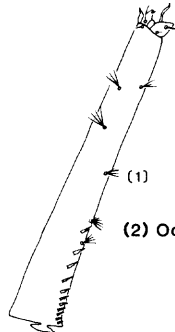
- (1) Seta 1-C of head long and slender, length about 0.1 mm
 (2) Siphon with 3 lateral pairs of seta 1-S

antennatus

- (1) Seta 1-C shorter, slightly stouter
 (2) Siphon with 2 lateral pairs of seta 1-S



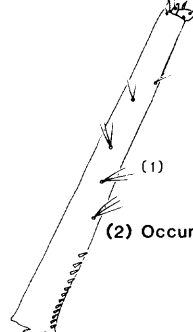
- (1) Seta 1-S distinctly shorter than diameter of siphon at point of attachment



- (2) Occurring in southern part of Arabian Peninsula

univittatus

- (1) Seta 1-S about as long as diameter of siphon at point of attachment



- (2) Occurring throughout southwestern Asia and Egypt

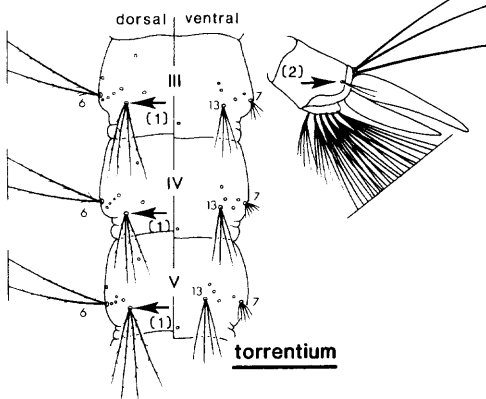
perexiguus

JRL

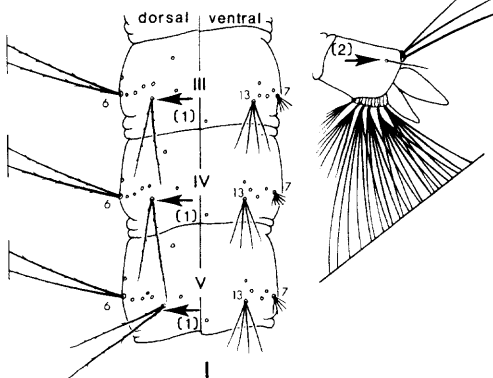
From PLATE 17: seta 1-S long, in 4 pairs; seta 6-VI double

PLATE 18

- (1) Seta 1-III-V usually with 4 or 5 branches (sum of their branches on 1 side of abdomen always equalling 10 or more, usually more)
 (2) Seta 1-X usually double



- (1) Seta 1-III-V usually with 1 or 2 branches (sum of their branches on 1 side of abdomen not exceeding 10, usually 6 or less)
 (2) Seta 1-X usually single



- (1) Seta 1-C unpigmented, sides smooth



- (2) Seta 13-T of thorax distinctly shorter than seta 12-T

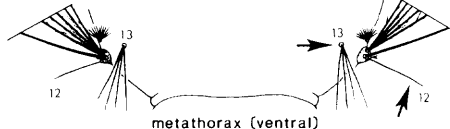


- (3) Widespread species

- (1) Seta 1-C pigmented, usually spiculate in middle



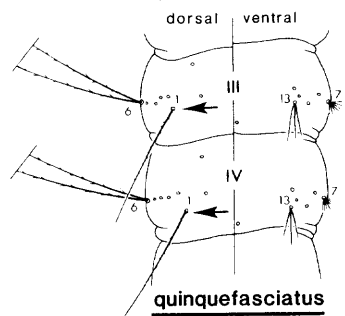
- (2) Seta 13-T as long as 12-T



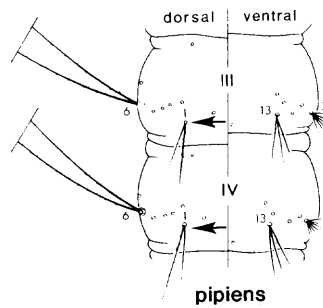
- (3) Occurring in Pakistan and perhaps Afghanistan and Iran

vagans

Seta 1-III,IV of abdomen usually single ★



Seta 1-III,IV usually double ★



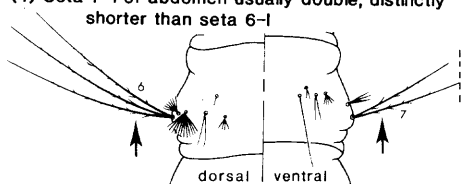
★ This character is unreliable in central and northeastern areas of the Arabian Peninsula where introgressed populations (hybrids) occur.

JRL

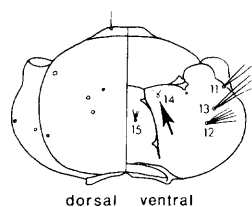
From PLATE 15: some or all comb scales spinelike

PLATE 19

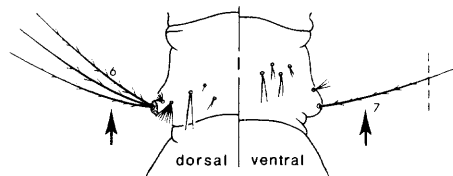
- (1) Seta 7-I of abdomen usually double, distinctly shorter than seta 6-I



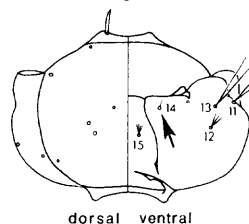
- (2) Seta 14-C of head with 2 or more branches



- (1) Seta 7-I usually single, about as long as 6-I

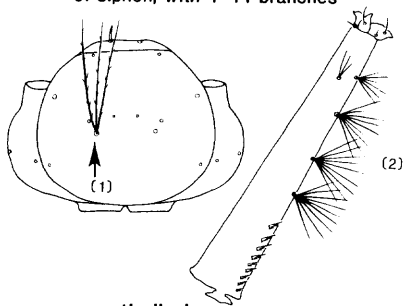


- (2) Seta 14-C single

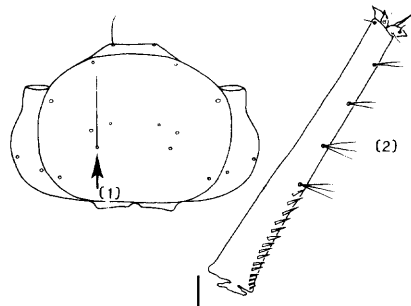


to PLATE 20

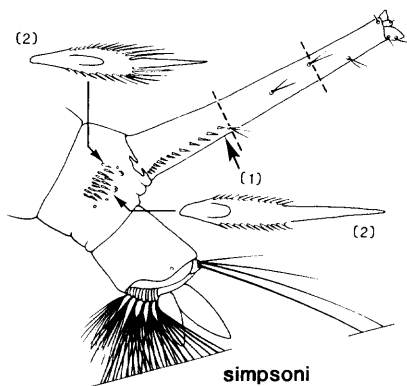
- (1) Seta 5-C of head with 3 or 4 branches
(2) Seta 1-S arising close to posterior midline of siphon, with 4-11 branches

theileri

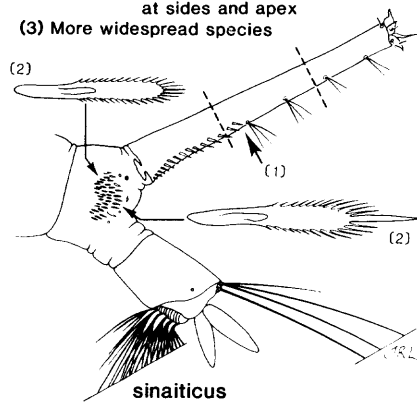
- (1) Seta 5-C with 1 or 2 branches (usually 1)
(2) Seta 1-S more lateral in position, with 1-4 branches



- (1) Pecten on proximal one-third or less of siphon
(2) All scales of comb spinelike
(3) Occurring in southern part of Arabian Peninsula

simpsoni

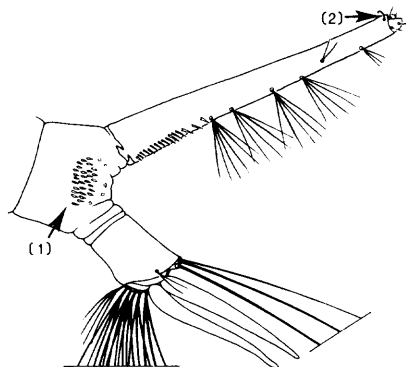
- (1) Pecten longer, about 0.4 of siphon length
(2) Some anterior scales of comb evenly fringed at sides and apex
(3) More widespread species

sinaiticus

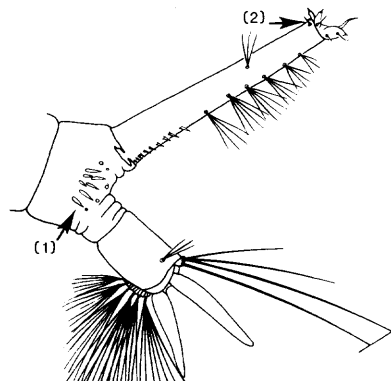
From PLATE 19: seta 7-I as long as 6-I; seta 14-C single

PLATE 20

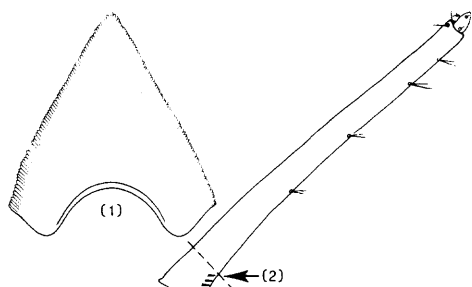
- (1) Comb with more than 25 scales
(2) Seta 2-S of siphon long and curved

mimeticus

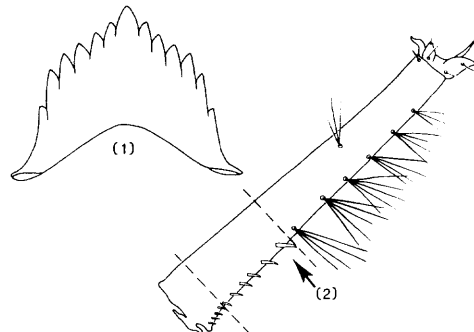
- (1) Comb with no more than 10 scales
(2) Seta 2-S long or short, always straight



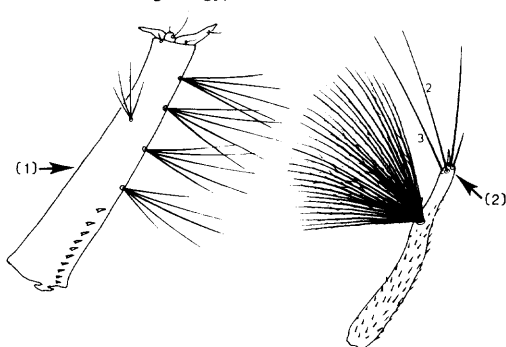
- (1) Dorsomentum of head a straight-sided triangle with minutely serrated margins
(2) Pecten very short, less than 0.1 of siphon length

bitaeniorhynchus

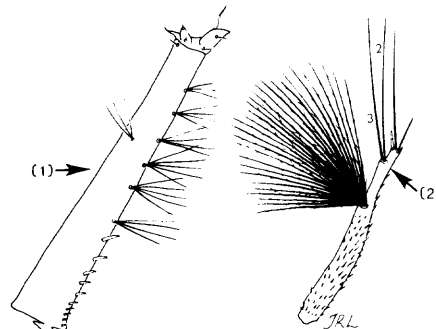
- (1) Dorsomentum an imperfect triangle with large teeth
(2) Pecten much longer, about one-third of siphon length



- (1) Anterior margin of siphon distinctly curved
(2) Setae 2- and 3-A inserted at apex of antenna
(3) Occurring in Egypt and Israel

poecilipes

- (1) Anterior margin of siphon straight
(2) Setae 2- and 3-A inserted subapically
(3) Occurring in Iran, Afghanistan and Pakistan

pseudovishnui